

## REMARKS

### File History

In the latest substantive Office action of 11/29/2005, and for the present application (*effective filing date: 8/26/2003*), the following allowances, rejections, objections, requirements and other actions appear to have been made:

- > Claim 19-23 were finally restricted out.
- > **Claims 1-4, 7-11, 16-17** were rejected under 35 USC §102(b) as being fully anticipated by **Xiaobing et al** (US 5,387,556, issued 2/7/1995 and based on an application filed 2/24/1993).
- > **Claims 24-26** were rejected under 35 USC §102(e) as being fully anticipated by **Chiu et al** (US Pub 2004/0157,444, published 8/12/2004 and based on an application filed 2/10/2003).
- > **Claims 5-6** were rejected under 35 USC §103(a) as being obvious over **Xiaobing** as combined with **Tang** (US 6,156,485 issued 12/5/2000).
- > **Claims 14-15** were rejected under 35 USC §103(a) as being obvious over **Xiaobing** as combined with **Ueda** (JP pub 11-097428 4/9/99).
- > Dependent Claims 12-13, 18, 27-30 were indicated to contain allowable subject matter.
- > **Claims 1-18, 26-30** were rejected under 35 USC §112, paragraph 2 for being unclear regarding "sufficiently small". Also Claim 7 re "the fibers". Also Claim 26 re "the ratio".

### Summary of Current Response

Claims 1, 7, 8, 24 , 26 are amended.

Claims 19-23 are canceled without prejudice.

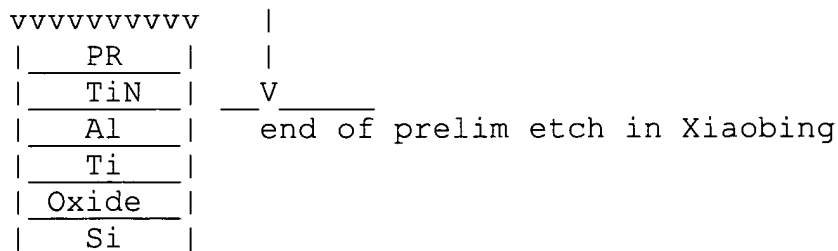
Claims 31-40 are newly presented.

Arguments and evidence are presented concerning support to amendment to the claims and concerning the applied art and its proposed combination.

### Applicants' Overview of Outstanding Office Action

Applicant sees the outstanding Office action of 11/25/2005 as having the following major features (1)-(2):

(1) Re Claim 1: Overlooked in the action is the fact that the relied-upon Xiaobing examples have no hadmask/ARC interface regions as is recited in the preamble of Claim 1. A fair reading of Xiaobing col. 5. lines 34-43 produces the following picture:



Xiaobing teaches to place G-line PR directly over the upper TiN layer. The preliminary etch uses the soft PR as the pattern to be copied into the metallic TiN layer. Xiaobing is silent about having noticed any residue during this preliminary etch between the resist layer and the TiN layer.

The "residue" of Xiaobing col. 5, line 64 is that which remains after the main etch, namely, after etching has proceeded through the whole aluminum stack, not just through the upper PR layer. Applicant is not disputing the examiner finding that Table I (Xiaobing col. 7) shows the recipe for the "preliminary" etch through the upper TiN layer of examples 1-4 (col. 5) and that this Table I shows a recipe of  $\text{BCl}_3/\text{Cl}_2/\text{N}_2$ . It is noted that Xiaobing was filed in

1993 and uses G-line lithography (col. 5, line 39) and 800 nanometer spacing minimum between features (col. 5, line 43). This is a much older and more-broadly spaced pitch than the one that causes problems in modern day UV lithography and its tighter spacings. (See new Claim 31). A more detailed explanation follows below and includes reasons why the preamble of Claim 1 is part of its limitations.

(2) Re Claim 24: Overlooked in the action is the fact that the structures of Chiu have no metal-containing ARC layer as is recited in the preamble of Claim 24. While true that paragraph [0056] of Chiu says "A common ARC is TiN, which may be deposited by sputtering, ..." [*Emphasis added*], Chiu in fact teaches layer 12 of Figs. 1-5 as being an "organic ARC". (See paragraphs [0047, --also describes it as BARC with amorphous carbon], [0051], [0072], [0088], [0010], [0090-0091], [0094], [0108], where not all of these directly define the "first" embodiment of Figs. 1-5.)

In view of the above, it is respectfully submitted that a prima facie case of unpatentability has not been made out.

#### Applicant's Detailed Reading of the Xiaobing reference

It is regrettable that Xiaobing '556 has no drawings and thus makes it difficult to envision the structure formed and the sequence of processes applied. Xiaobing '556 forms the foundation of most all art-based rejections. It is important to properly ascertain the scope of the prior art as represented by Xiaobing.

Xiaobing col. 5 sets forth Examples 1-4 wherein lines 34-50 describe the following sequence:

The wafers used were [(6)] silicon wafers of 200 mm diameter coated successively with 5000 .ANG. [(5)] oxide layer; 1000 .ANG. layer of [(4)] titanium; 1.0 micron layer of [(3)] aluminum, containing 0.5% copper; a [(2)] TiN layer of 4000 .ANG.; and [(1)] resist in selected areas in a thickness of 1.45 microns. A G line photoresist material was used. The resist was placed on about 50% of the surface area of the wafer, to generate features of varying spacing and size. The highest density features were spaced apart by 0.8 microns, where the features were 0.6 microns wide.

The wafers were etched in three stages, a preliminary etch, a main etch, and a final etch. Two different types of final etches were used. The process conditions for the preliminary and final etches are summarized in Table 1. The preliminary etch was timed to go to breakthrough, i.e., where the overlayer of TiN was etched through so that the aluminum layer was beginning to be etched. The main etch was conducted until the aluminum alloy was etched through, and etching of the underlayer of TiN began.

*[Emphasis and bracketed text added.]*

The six (6) layers discussed above are thus fairly shown in the above Applicants' Overview where the "preliminary etch" cuts through the uppermost layers 1 and 2 (PR and TiN). There is no hardmask-to-TiN interface in these relied-upon examples. As for the lower Ti layer (4), there is no immediately overlying oxide layer.

Xiaobing col. 6, lines 21-24 make it clear that bottom residue is observed at the end of the etch process (after the Al has been etched through) and that this particular kind of residue is very easy to "completely" remove with, for example, an ACT-150 dip. Thus the residue of Xiaobing is not the same as that defined by Claim 1 (as now amended), namely, "micromasking residue remaining within an exposed interface region of an oxide-based hardmask layer and an underlying metal-containing anti-reflection coating layer (ARC layer) after the hardmask layer has been patterned, where the residue includes nodules containing one or more oxides and each having a base anchor portion and an upper body portion" *[Emphasis added]*.

### **Simplified Explanation of Present Application**

Referring to Fig. 1 of the present application, it can be appreciated that a particular sequence of etch steps will be carried out. Conventionally, after a fluorine-based etch of the TEOS layer (160) is carried out, a chlorine-based etch of the metal-containing ARC layer (152, TiN in this case) would have been carried out.

However, Applicants ran into a problem with this particular sequencing of material layers because of interaction believed to occur between the oxygen-containing PE-TEOS layer (160) and the metal-containing ARC layer (152, TiN). The nodules 255 seen in Fig. 2A

were, by proof of their continued presence, resistant to simple removal by use of the fluorine-based etch (201) of the TEOS layer. They were also resistant to simple removal by the conventionally used chlorine-based etch (202) directed to the TiN layer 252. If the nodules 255 are not specially removed, a danger is created of creating short circuiting due to the micromasked aluminum spots 244b shown in Fig. 2B. This was not a problem in older technologies such as that of Xiaobing where spacings between metal lines were much wider.

Referring to Fig. 3, item 350 (bottom right) it was discovered that a special residue removal process could be used to get rid of these etch-resistant nodules. The conventional methods didn't work. One of the discoveries was that the chemical attack on the nodules had to be by way of a relatively small reactive agent like  $\text{Cl}_2$  (356) which could get under the oxide-containing heads of most nodules and attack the metal-containing anchors by forming volatile byproducts 357 (e.g.,  $\text{Ti}_x\text{Cl}_y$ ) of the metallic anchor.

The art of record neither recognizes this special nodules problem nor provides a solution for it. Incidentally, if anything said here contradicts the specification or appears to narrow definitions provided in the specification, then the specification controls. This is meant to give the examiner an executive briefing on the subject matter covered.

#### **Partial Traverse of §112 rejection --it's as good as the subject matter allows**

Original Claim 1 recited "the first agent being sufficiently small in size to operatively enter reaction zones of the base anchor portions of the residue nodules so as to react with the first metal element, if any, in the respective base anchor portions". [*Emphasis added.*]

The outstanding grounds of rejection assert that this renders Claim 1 indefinite because the phrase "sufficiently small" is relative to the size of the nodules.

Applicant sees this rejection as having both a valid basis in one regard and a traversable basis in another.

Because original Claim 1 did not say which nodules and because some nodules could be so shaped, so crowded, and/or so small (see the smaller nodules at 350 of Fig. 3), that even chlorine molecules may not be able to get in to attack the anchors of these too-small nodules

or too tightly crowded nodules, it is more precise to say "at least some" nodules as is done in the now-amended Claim 1. Note specification paragraph [0036] which discusses that "Access of the chemically reactive agent (e.g., chlorine) to the base or bottom stems may be limited due to crowding by adjacent nodules and/or fibers or due to short stem height." The "at least some" aspect now added to Claim 1 is inherent in the disclosure because the examples given did get rid of the observable residue and use of the small-sized chemical attacking agent was found to be essentially necessary in getting rid of the otherwise difficult to remove residue. Specification paragraph [0036] admits that the chlorine may not be able to get to every anchor due to possible blocking mechanisms. So, in this regard, the examiner is correct.

However, if the examiner intended to convey that it is per se indefinite to define the size of the first agent as being sufficiently small in size to operatively enter reaction zones of the base anchor portions of the residue nodules, then the case law does not support such a position.

Not every invention is capable of description to an exactitude that an examiner may desire (or that an inventor may desire). It is well established in case law that certain relative definitions are as good as the subject matter allows and that they fully serve their function of "reasonably" warning potential infringers of where the metes and bounds of the claimed subject matter lie. For example, In re Venezia 189 U.S.P.Q 149 (CCPA 1976) it was held that the language "adapted to be fitted" imparts a definitive structural limitation. This holding was followed in Pac-Tec Inc. v. Amerace Corp. 14 U.S.P.Q.2d 1871, 1876 (Fed. Cir. 1990). In Orthokinetics Inc. v. Safety Travel Chairs Inc. 1 U.S.P.Q.2d 1081, 1088 (Fed. Cir. 1986) it was held that the language, "so dimensioned as to be insertable [in an external entity, namely,] doorframe of an automobile" is as accurate as the subject matter (wheelchairs) permits. These court decisions show that a claimed structure can be limited by reference to external events and/or structures. Thus what Applicant is here doing by defining the first agent relative to the nodules is not at all incongruent with existing case law. In Fig. 3, Applicant demonstrates written description appreciation of the concept that the chlorine (356) should be able to get under the mushroom like heads of the nodules and chemically attack their metal-containing bases 355b.

See also, In re Marosi 218 USPQ 289, 292 (Fed. Cir. 1983) where it was held that patent applicants do not have to provide more than "general guidelines" for allowing an

ordinary artisan to determine what lies within the scope of the claim (what constitutes "essentially free of alkali metal" in Marosi's case). The PTO cannot force an applicant to draw a hard line in the sand. And in some cases, such as this one, it is about as good as the subject matter will allow. Applicant was not able to go in with a ruler and measure the sizes of the stems of the nodules. They were covered up by the heads of the nodules.

It is respectfully submitted that, in this regard, the outstanding grounds of rejection for indefiniteness against Claim 1 are in error and reconsideration is respectfully requested.

Re the indefiniteness rejection raised against Claim 7, recitation of the fibers is removed, but in doing so Applicant is not surrendering use of the treatment to an interface zone that has both nodules and nanofibers. See Fig. 2A which shows both nodules and fibers.

Re Claim 26, the ratio of y to x is inherent. Nonetheless to avoid arguing over it, Applicant rephrases the concept of the inherent ratio as a calculated ratio.

Re Claim 24 and weight to the microscopic observability, the examiner has a good point in a different respect. When the reducing method works 100%, then the residue will not at all be observable. Thus the qualifier "otherwise" was added. However as to physical possibility of microscopically observing or not, the PTO position is not understood. The interface can have nanofibers (e.g., TiO whiskers) that are not seen in the SEM at a given level of magnification. The ability to be seen microscopically is a physical attribute.

#### **Preamble of Claim 1**

Even though the Office action did not bring this up, it should be apparent that the preamble of Claim 1 is part of its limitations because the body makes antecedent reference to the preamble. See Bell Communications Research, Inc. v. Vitalink Communications Corp., 55 F.3d 615, 620 (Fed. Cir. 1995). See also Eaton Corp. v. Rockwell Int'l Corp., 323 F.3d 1332, 1339 (Fed. Cir. 2003).

#### **Claim 24 Art Rejection and reliance on the Chiu Publication**

Applicant notes that Chiu was not published before the filing date of the present application and that Chiu is applied under 35 USC §102(e). Irrespective of the below detailed look at Chiu, Applicant reserves the right to attack the use of Chiu as a prior art reference under the legal fiction of 35 USC §102(e). 102(e) requires a §112 level of description. It is not

clear that Chiu meets this level of adequate disclosure. Chiu is confusing. For example, Chiu at col. 3, line 2 says that Figs. 1-6 address a silicon based surface while the detailed description of say, paragraph [0045] indicates it is an oxide based surface. Thus there is a question whether Chiu satisfies all the requirements of 35 USC §112.

Assuming arguendo that Chiu is applicable prior art, when read in whole, paragraphs [0047], [0051], [0072], [0088] teach that the ARC layer 12 is a carbonaceous "organic" ARC and not a metal containing one such as TiN. The relied on paragraph [0056] cannot be read in isolation. It is part of the text beginning at [0051] which discusses ARC both generally and then in specifics. Those skilled in the art will readily appreciate that the TiN ARC mentioned at paragraph [0056] is by way of general discussion and is not describing the "organic" ARC layer 12 of paragraph [0051] where the latter is what is represented by layer 12 of Figs. 1-6. As Applicant suggested at the very beginning, Chiu is less than a model of clarity and may not be applicable under 35 USC §102(e). It is not permissible to use speculation and to use Applicant's disclosure as a guiding light for inferring into Chiu things that are simply not there. Chiu does not teach the ordinary artisan about the residue problem that may occur between an oxygen-containing hardmask and a metal-containing ARC layer beneath it.

### **Rejections made against the Dependent Claims**

Re Claim 2, there is 0 HCl in the preliminary etch of Table III. And besides, there is no hardmask. In rejecting the claims, it is incumbent upon the examiner to first establish that nodules are present in the relied-upon art. (And even if they were there, the doctrine of accidental anticipation will kick in because the art fails to show any recognition of such nodules. See generally Chisum §3.03. See also the US Supreme Court decision of Eibel Process Co. v. Minnesota & Ontario Paper Co. 261 US 45 (1923).)

Re Claim 5 (rejected on Xiaobing plus Tang), the PTO finally addresses the issue of the missing hardmask but fails to appreciate that col. 1, line 15 of Xiaobing is actually distinguishing between organic PR and oxide-hardmasks; and not teaching to use hardmasks in the relied-upon "examples" of Xiaobing. The "Examples" (e.g., 1-4) of Xiaobing use only organic PR (G line photoresist) and not a hardmask. Xiaobing provides no enabling disclosure re etching through a hardmask. It is even questionable whether Xiaobing is enabling re the



placement of TiN directly on Al since normally a Ti adhesion layer is called for in between TiN and aluminum. A person skilled in the art would question the viability of Xiaobing's disclosure.

Tang teaches to use an etch recipe comprising **Cl<sub>2</sub>, BCL<sub>3</sub> and CF<sub>4</sub>** at col. 6, line 31 for simultaneously cutting through PEOX and ARC. Tang does not mention anything about a special residue removing step. It is not explained why an ordinary artisan would choose to replace the Cl<sub>2</sub>, BCL<sub>3</sub> and CF<sub>4</sub> recipe of Tang with something else. It is not explained what would motivate the ordinary artisan to combine Xiaobing and Tang. Therefore a prima facie case of obviousness is not made out against Claim 5.

Re Claim 7 (rejected on Xiaobing col. 3, line 43), the relied on part of Xiaobing appears to be discussing use of a "process gas" for etching all the way down in one step at least to the aluminum layer (see col. 3, line 61) without stop. Thus there is no recognition of a nodules problem. The relied on part of Xiaobing (col. 3, line 43) is silent as to resist structure being etched through. It is impermissible to use speculation in place of evidence. Col. 4, line 8 of Xiaobing requires the "process gas" to etch through aluminum and its alloys.

Re Claim 8 (rejected on Xiaobing Table 1), the rejection fails to account for all the limitations of Claim 8, namely: "the second agent being sufficiently large in average mass for physical bombardment purposes to operatively weaken attachments of the base anchor portions of the residue nodules to the interface region so as to thereby encourage break away and removal of the residue nodules from the interface region" [*Emphasis added.*]

Re Claim 14 (rejected on Xiaobing plus Ueda), Ueda teaches to use photoresist, not a hardmask. Xiaobing also teaches only photoresist in the relied upon examples.

## CONCLUSION


Claim 1 requires that a special kind of residue remain after etching of the hardmask, namely, "where the residue includes nodules containing one or more oxides and each having a base anchor portion and an upper body portion". The art of record does not even meet this basic requirement.

In light of the foregoing, Applicant respectfully submits that the outstanding grounds of rejection are overcome. Reconsideration and allowance are respectfully requested. Should any other action be contemplated by the Examiner, it is respectfully requested that he/she contact the undersigned at (408) 392-9250 to discuss the application.

[It is believed that all outstanding grounds of rejection have been overcome or traversed in light of the foregoing. Applicant respectfully requests entry of the amendments and reexamination with favorable outcome. Should any other action be contemplated by the Examiner, it is respectfully requested that he/she contact the undersigned at (408) 392-9250 to discuss the application.]

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 50-2257 for any matter in connection with this response, including any fee for extension of time and/or fee for additional claims, which may be required.

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on February 28, 2006.

 2-28-06

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